



Water Quality and Hydrologic Issues Related to the Pebble Project, Alaska

Ann Maest, PhD, Cam Wobus, PhD, and Connie
Travers, MS
Stratus Consulting, Inc.
Boulder, CO

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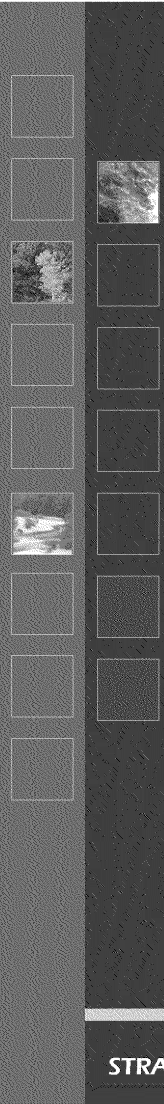
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Overview

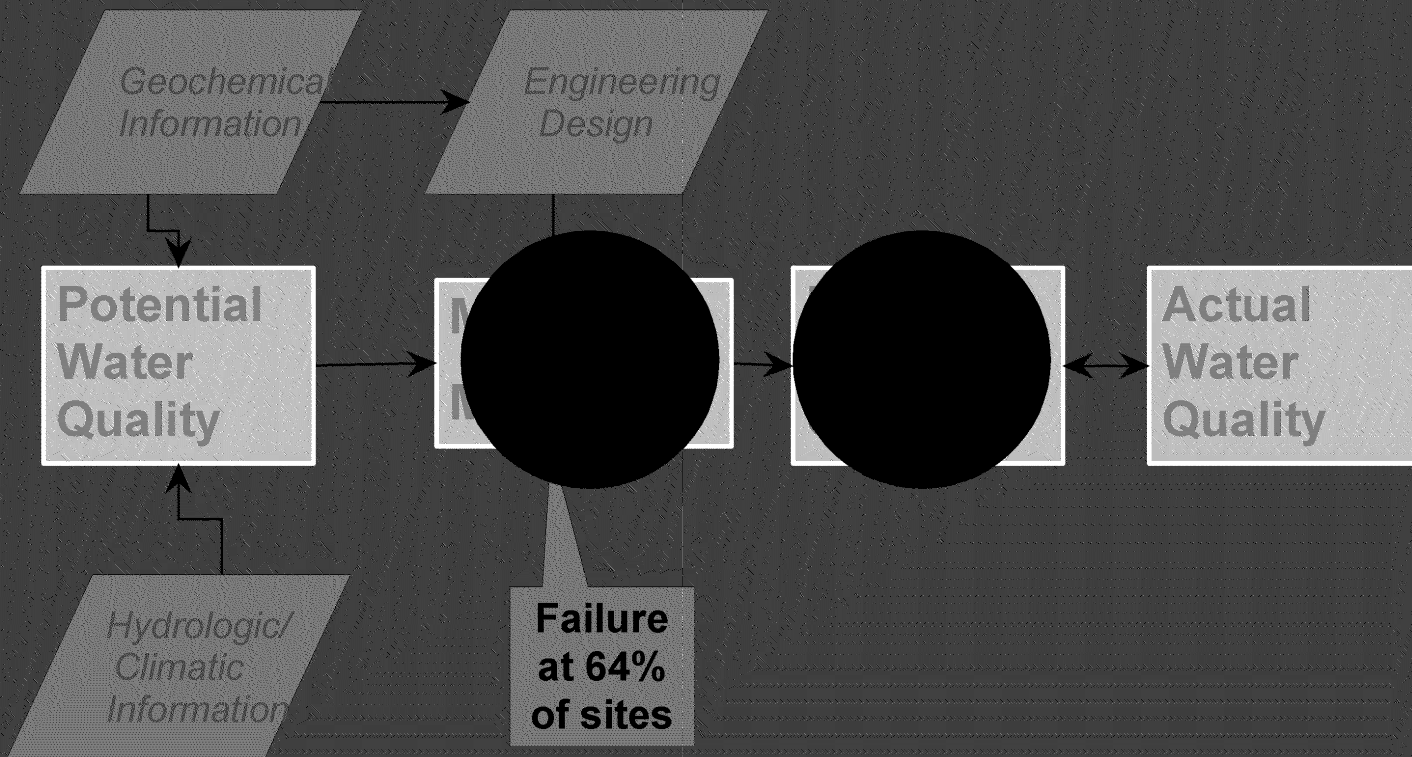
- Environmental record at large hardrock mines
- Overview of hydrology and geochemistry at Pebble Project
 - Purpose: evaluate site-specific vulnerabilities of migratory and resident fish to mining impacts



Performance Evaluation: Comparison of Predicted and Actual Water Quality at US Hardrock Mines

- Examined performance at large hardrock mines in the U.S.
 - 183 major mines, 137 NEPA mines
 - 71 NEPA mines reviewed
- 104 EISs reviewed for 71 mines
- Compared EIS predictions to actual water quality for 25 case study mines

Predicted vs. Actual Water Quality



Performance Evaluation: Post-Mining Surface Water Quality

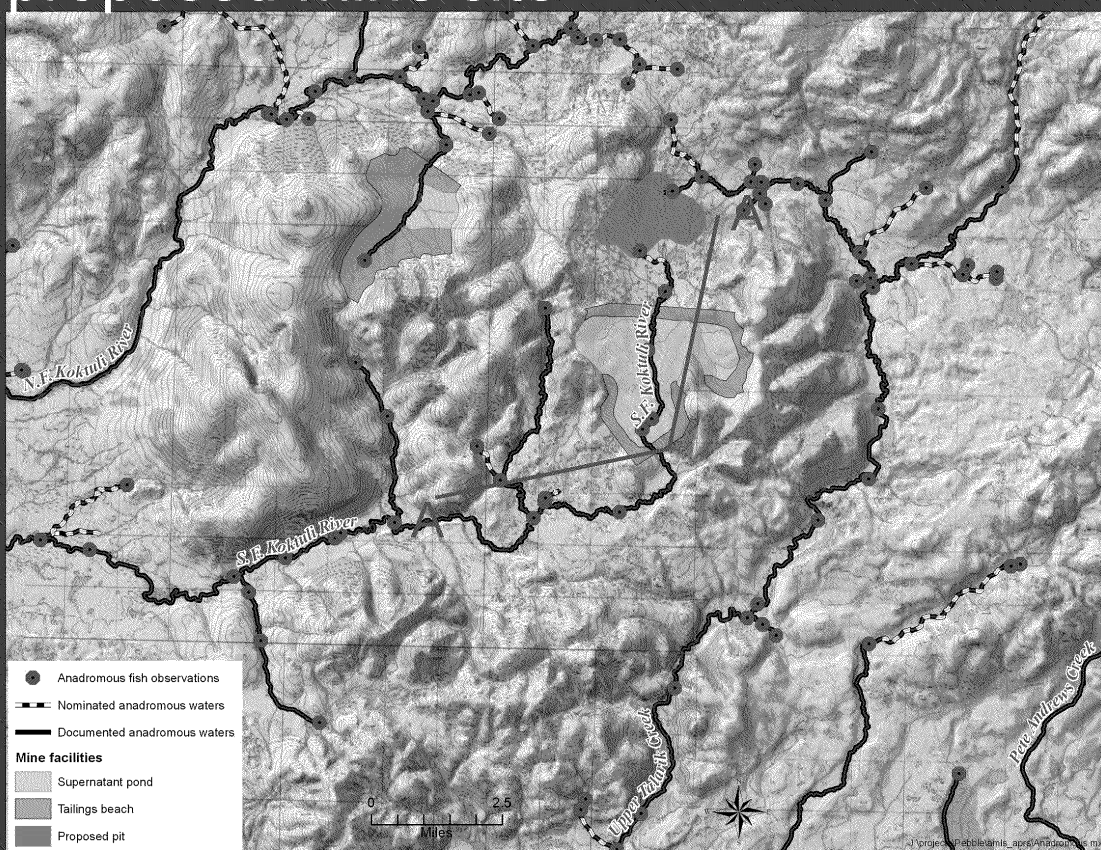
	# Mines	Percent (%) with Impact to Surface Water	Percent (%) with Exceedences of Standards in Surface Water	Percent (%) with Exceedences that Predicted no Exceedences
Mines close to surface water with mod/high ADP or CLP	13	92 (12/13)	85 (11/13)	91 (10/11)
All case study mines	25	64 (16/25)	60 (15/25)	73 (11/15)

Performance failures at virtually all case study mines in proximity to surface water. Primary causes of failure: inadequate mitigation measures and geochemical characterization.

Factors that Increase Environmental Vulnerability at Mine Sites

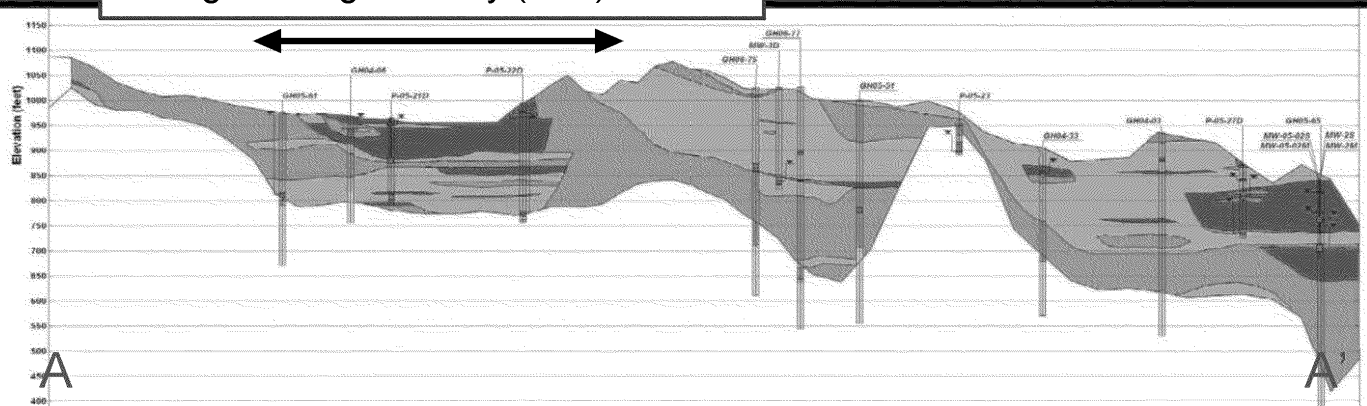
- Proximity to sensitive environmental biota and water resources
- High degree of hydrologic connection
 - Increases transport of heavy metals – low ability to control wastes
 - Watershed coverage (with wastes) changes hydrograph and upwelling areas
- High potential to leach contaminants
 - Ore and wastes will generate acid and leach heavy metals
- Low buffering in streams
 - Low hardness, alkalinity, DOM in streams

Pebble Site –Sensitive Biota throughout proposed mine site



Site Hydrogeology

Tailings Storage Facility (TSF) Site A



- 200+ ft of highly permeable sand and gravel
 - *Easy movement of contaminants*
- Unlined tailings storage plans rely on low K materials
 - *Not present beneath all tailings areas*
- Resource estimates have grown since 2006 water rights application (only for Pebble West!)
 - *Mine facility footprints will be larger*

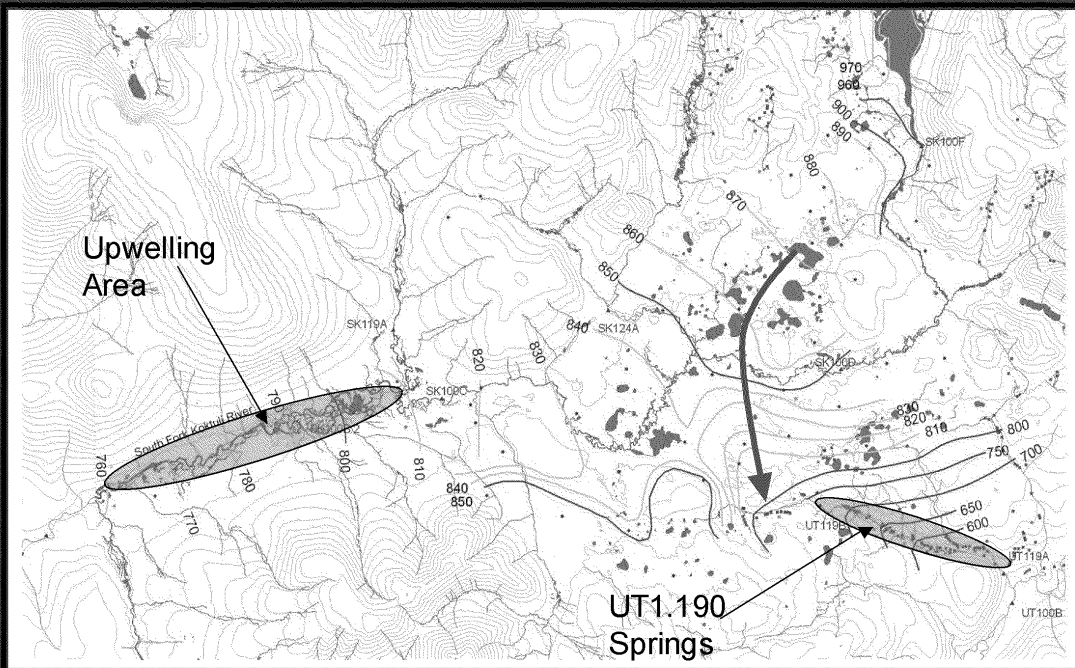
Legend

- Sand, silty sand
- Clay, silty clay
- Gravel, gravelly sand
- No recovery
- Bedrock
- Borehole screen
- ▼ Water level elevation
(data from August 14-16, 2006)

Sources: WMC, 2008; NDM, 2006 SFK water rights application

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Natural Water Transfers

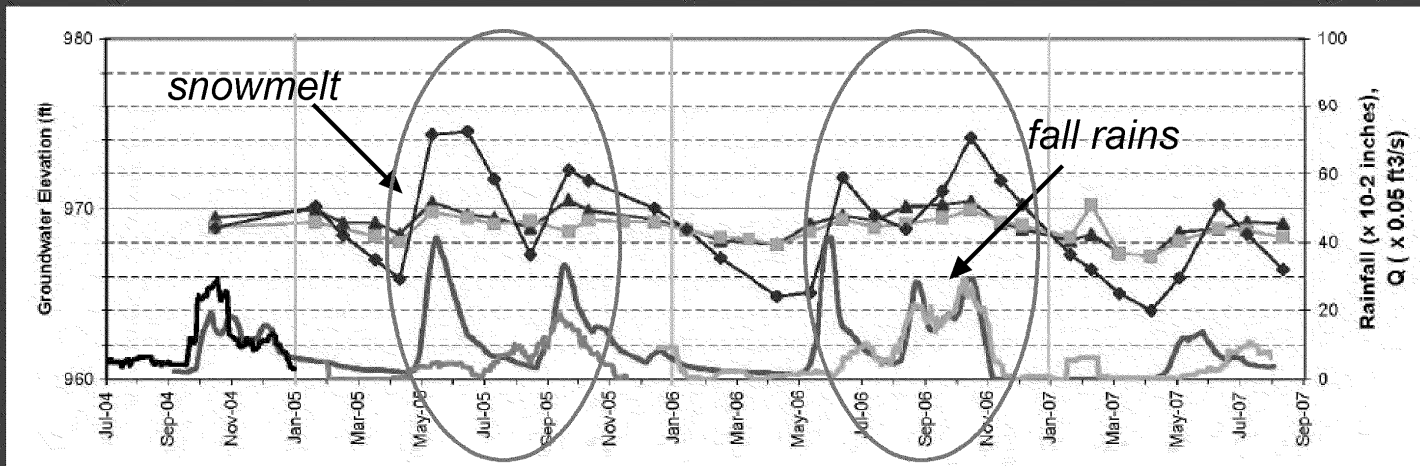


- ~25 cfs of surface water moves from SF Kaktuli to Upper Talarik basin – *contaminants will cross basins*
- Groundwater upwelling – *salmon spawning reduced if upwelling reduced*

Source: WMC, 2008

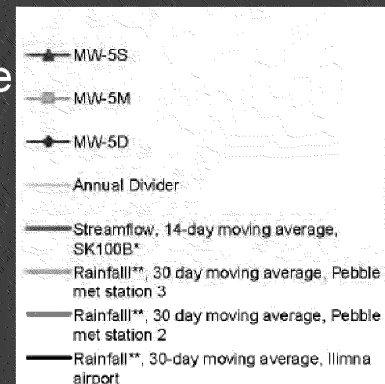
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Surface Water and Groundwater Connections (just upstream from proposed TSF)



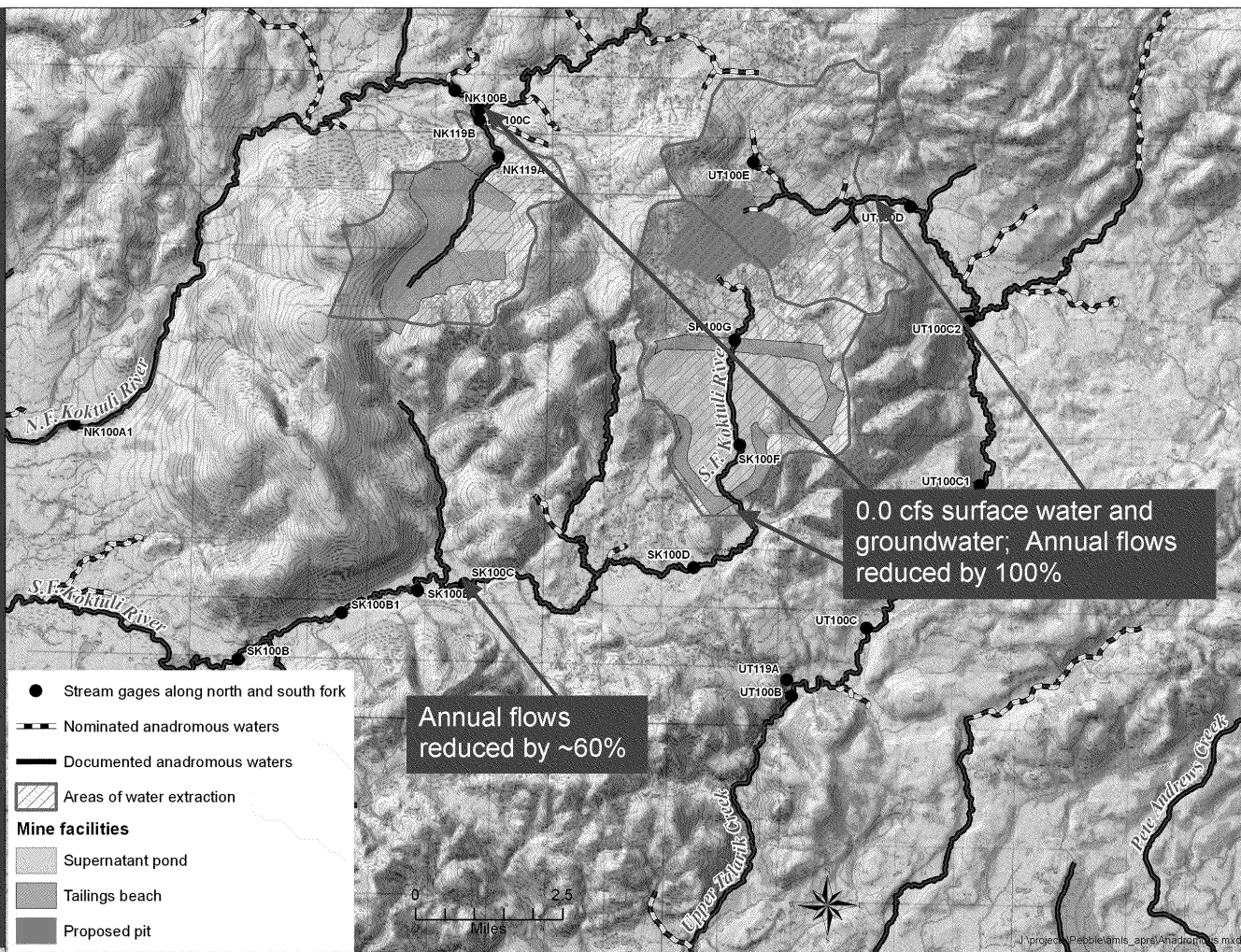
- Deep groundwater responds to changes in surface water flow and precipitation

- *Conduits for flow between surface water and groundwater*
- *Contaminant migration pathways beneath TSF*



Source: WMC, 2008

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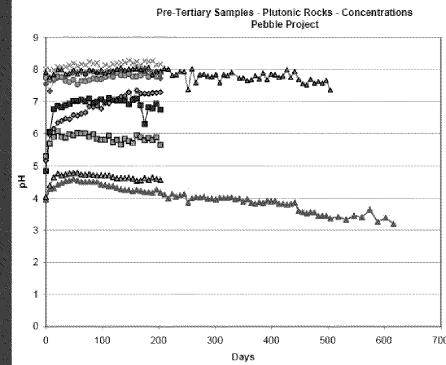
Reduction in flows = reduced habitat for migratory and resident fish

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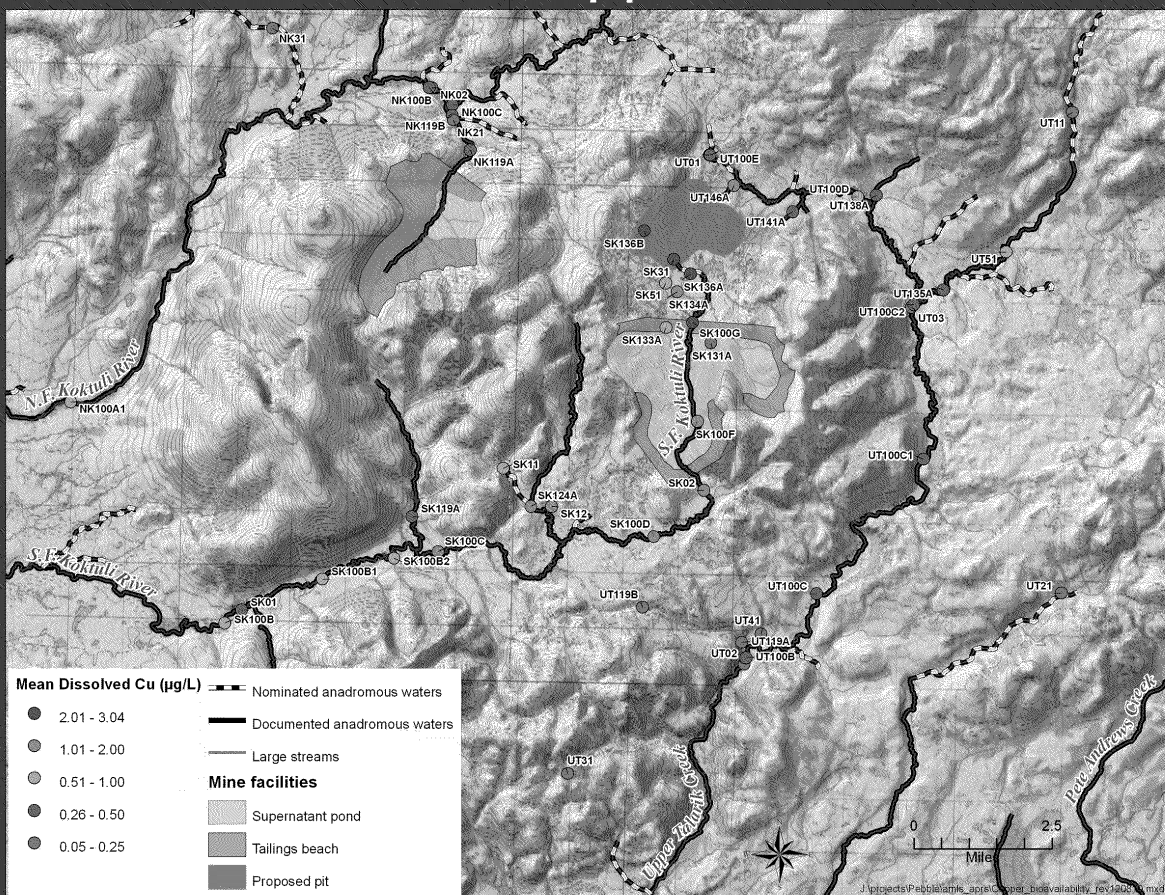
Site Geochemistry

Water Quality Baseline

- Deposit is an acid-producer
 - “...it would take about 40 years for nearly all pre-Tertiary rock to become acidic under site conditions.” (NDM, 2005)
- Low alkalinity (~10-30 mg/L as CaCO_3), hardness and DOM
- Higher susceptibility to stream acidification and metal toxicity to fish



Mean Dissolved Copper Concentrations

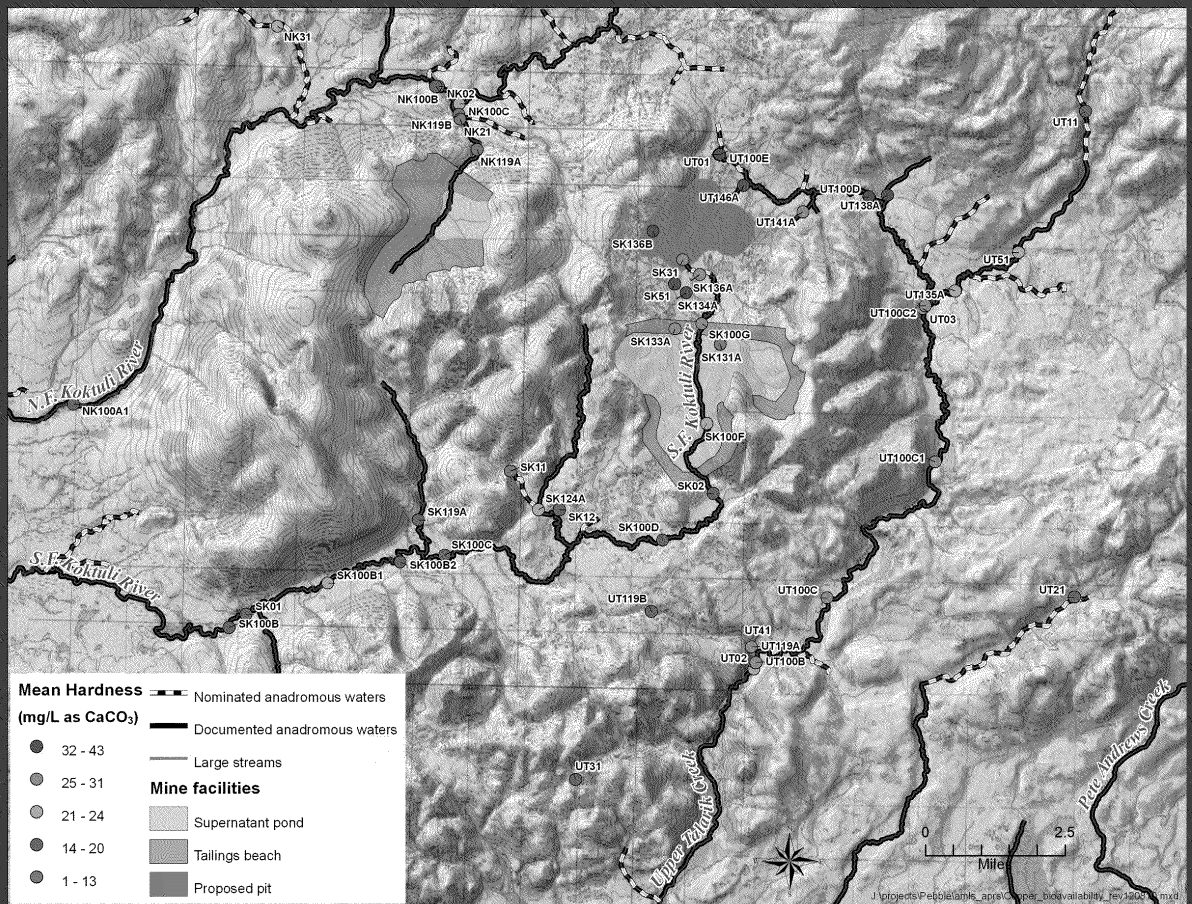


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Cu concentrations low in fish-bearing surface waters

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Mean Hardness Values

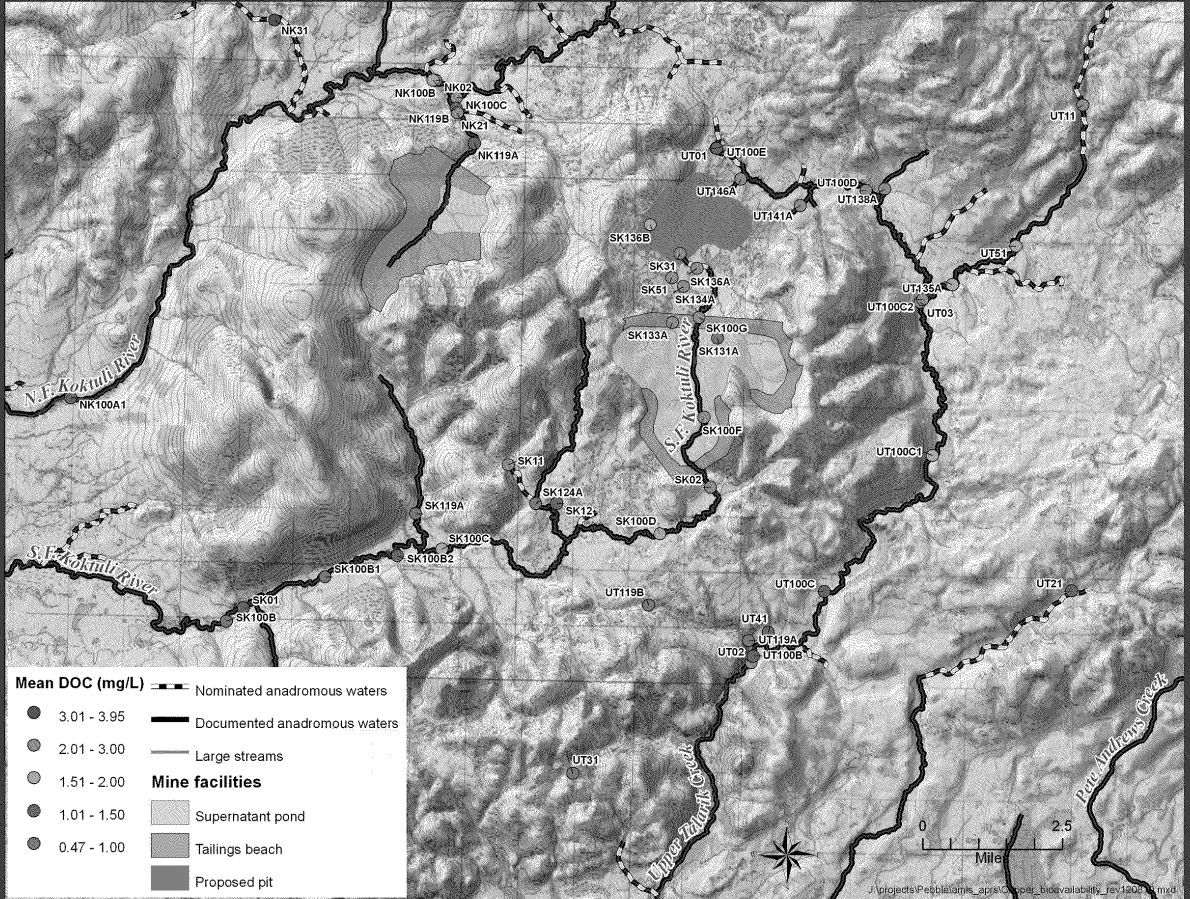


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**Hardness very low = low buffering capacity
and increased Cu toxicity**

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Mean Dissolved Organic Carbon

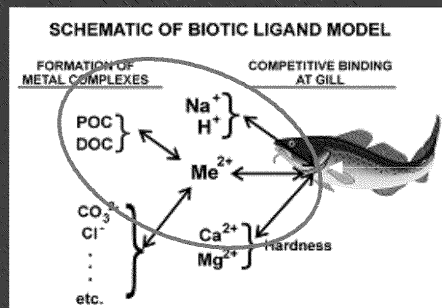


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*Low DOC in fish-bearing surface waters =
higher toxicity*

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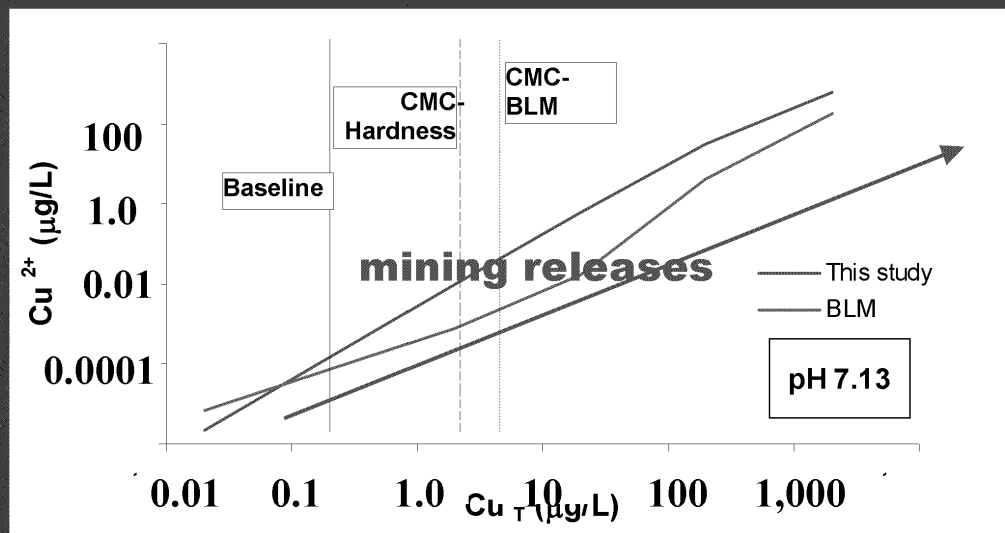
Site-specific Cu Binding Studies



- Purpose: Evaluate binding properties of ambient DOM
 - Natural organic matter can bind copper and decrease toxicity to aquatic biota
- EPA has approved use of BLM for Cu acute WQC
 - “Canned” input values for DOM; if site-specific binding varies from assumptions, different toxicity
- TNC laboratory studies of site-specific copper binding in NFK, SFK, UT
 - Pebble Project DOM has less ability to complex Cu than assumed in BLM

BLM Comparison – North Fork Koktuli Site

- 2-10 times more free Cu with ambient DOM than predicted by BLM = increased Cu toxicity



Conclusions

- Failure rates at large mines are high – mitigation and prediction failures
- Pebble Project area extremely susceptible to adverse effects
 - High acid-generation and contaminant leaching potential, close proximity to water resources and sensitive biota
 - High hydraulic connectivity – extensive contaminant transport, reduced ability to control wastes
 - Streams naturally low in components that ameliorate copper toxicity and buffer pH
 - Ambient DOM has less ability to complex Cu than BLM predicts – EPA model will underpredict toxicity to salmonids at this site

Conclusions (cont.)

- Mine plan guarantees irreversible adverse effects
 - Little to no experience with successfully controlling releases from mines of this size
 - Mine facilities will reduce flows, eliminate important salmon habitat, and adversely affect spawning and migration
- Hydrogeologic, geochemical, and ecological attributes of project area indicate that the site has a high degree of vulnerability with virtually no margin for error = high risk to vitally important fisheries



End

Additional work to support 404(c) ruling

- Integration and interpretation of all TNC data
- Biodiversity studies in areas of natural acid drainage
- Streamside copper toxicity study
 - Direct measurement of effects of increasing copper on resident salmonids
- Tailings seepage containment
 - Use recently-obtained bore hole logs to evaluate nature of geologic material and extent of low permeability layer beneath unlined TSF